

**The National Space Grant Office requires two annual reports, the Annual Performance Data Report (APD – this document) and the Office of Education Performance Measurement System (OEPM) report. The former is primarily narrative and the latter data intensive. Because the reporting timeline cycles are different, data in the two reports may not necessarily agree at the time of report submission. OEPM data are used for official reporting.**

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### **PROGRAM DESCRIPTION**

The National Space Grant College and Fellowship Program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states plus the District of Columbia and the Commonwealth of Puerto Rico. Annually, each consortium receives funds to develop and implement student fellowships and scholarships programs; interdisciplinary space-related research infrastructure, education, and public service programs; and cooperative initiatives with industry, research laboratories, and state, local, and other governments. Space Grant operates at the intersection of NASA's interest as implemented by alignment with the Mission Directorates and the state's interests. Although it is primarily a higher education program, Space Grant programs encompass the entire length of the education pipeline, including elementary/secondary and informal education. The Vermont Space Grant Consortium is a Capability Enhancement Consortium funded at a level of \$430,000 for fiscal year 2014.

### **PROGRAM GOALS**

Goals of the Vermont Space Grant Consortium (VTSGC) during the fifth year of our five-year award included continuing to foster development our network of colleges and universities, industries, and other organizations committed to the strengthening of science/mathematics/engineering fields (i.e. STEM) so as to increase capabilities and promote in interest aeronautics, space science and engineering, and related fields in the State of Vermont. The VTSGC has sought to encourage students at all educational levels ranging from K-12 through undergraduate and into graduate school to take pursue more studies in STEM areas, making connections with NASA, and to pursue careers in scientific and technical fields. Through our Undergraduate Scholarship, Graduate Fellowship, and Higher Education Programs, the VTSGC has addressed critical pipeline issues, helped train the next generation of professionals, and has especially encouraged women, members of underrepresented groups, and persons with disabilities. As a Capability Enhancement Consortium, a concurrent priority for the VTSGC is to concurrently strive to enhance research infrastructure in Vermont.

### **PROGRAM/PROJECT BENEFIT TO OUTCOME (1,2, & 3)**

Several illustrations will highlight the contributions made by VTSGC programs to the three outcomes that guide NASA's Education Portfolio. As a first illustration, there were two noteworthy outcomes related to Outcome #1. First, William Baker, a graduate student in electrical engineering at the University of Vermont, worked with the Satellite Servicing Capabilities Office (SSCO) at NASA Goddard to develop and demonstrate technologies for the robotic maintenance of satellites in orbit. Post graduation, Mr. Baker has accepted a job continuing his work in robotics as NASA Johnson Space Center. Second, two VTSGC-supported students from Norwich University have been accepted to pilot training school with the U.S. Air Force after graduation; one has attended the weeklong RockOn! rocketry payload workshop at NASA Wallops and the second was a summer intern at NASA Langley Research Center (Outcome 1, *Employ and Educate*).

A second illustration involved the support for a NASA Robotic Mining Competition (RMC) Team at the University of Vermont. The RMC is a national competition sponsored by NASA with final competitions held at NASA KSC in May each year. Based on the positive experiences from this competition, it is expected that the RMC team will become an annual activity. (Outcome 2, *Educate and Engage*).

A third illustration of the benefit to NASA Education Outcomes of our programs involves the VTSGC Awards Night Ceremony held in October last year. Our Awards Night generated considerable publicity for both the VTSGC and NASA in local media across the entire state and helped to highlight strategic partnerships with formal and informal STEM education providers, promote our efforts to advance STEM literacy, and raise awareness of NASA's mission among both Vermont's education community and the General Public (Outcome 3, *Engage and Inspire*).

## PROGRAM ACCOMPLISHMENTS

### ***Outcome 1: Contribute to the development of the STEM workforce in disciplines needed to achieve NASA's strategic goals (Employ and Educate)***

In order to provide NASA-related competency-building education and research opportunities for students and faculty researchers, the VTSGC has strived to make significant achievements and progress in our Research Infrastructure, Fellowship/Scholarship and Higher Education programs.

#### ***1.1 Research Infrastructure:***

As a Capability Enhancement Consortium, a priority goal of the VTSGC is increasing Vermont's Research Infrastructure in areas aligned with new and continuing NASA research priorities and technical needs. The primary program is our yearly "Faculty Research Proposal Competition." This competition is open to all full-time Vermont researchers at any Vermont college or university. Research Minigrants grants of up to \$5,000 are available to initiate research projects and collaborations with NASA colleagues. Travel Minigrants of up to \$2,000 are available to support faculty visits to NASA Centers for the purpose of exploring new contacts and collaborations or fostering existing ones. Finally, a small number of Small-Scale Grants of up to \$30,000 are available to faculty researchers for more mature research projects, typically wherein a NASA contact or collaborator has already been established.

Because an approximately six month delay in the arrival of Year 5 Space Grant funds from NASA headquarters, the Faculty Research Competition had a reduced number of supported small-scale grants. This shortfall was necessary to ensure that allocated graduate fellowships,

which were deemed to be of higher priority under the circumstances, would have sufficient funds. Three new faculty research grants were awarded by the VTSGC during the past year as a result of our 2014 Faculty Research Competition. One of these awards was a Small-Scale Grant, the second was a Research Minigrant, and the third was a Travel Minigrant. It should also be noted that all of the projects funded in our 2014 Faculty research Competition include the participation of undergraduate student researchers and/or graduate students.

A comparison of the progress reported above with the SMART goals and objectives described in the VTSGC's FY 2010 proposal package for the current funding cycle shows that targets for the current reporting period have mostly been met in terms of activity, although not so in total funds. The target range for faculty awards in our FY 2010 proposal included three or four annual Small-Scale Grants and two Research Minigrants. This year one reduced amount Small-Scale Grant and two Minigrants were supported by the VTSGC during the current reporting period. This shortcoming will be compensated by the availability of the unused late-arriving funds in next year's Faculty Competition as the current Space Grant award has received a no-cost extension through May 2016.

Of the four faculty investigators involved in these locally funded research projects, one was of Hispanic descent (25%). No female investigators were funded since there were no applications submitted. This was a very unusual development: in FY12, 60% of awards went to female faculty and in FY13, 33% of the awards went to faculty. Overall, we aspire to meet our overall target of 40% over the lifetime of this funding cycle and during the next year we will make special efforts to solicit applications from female investigators.

### 1.2 Undergraduate Scholarship and Graduate Research Fellowship Competitions:

Results of the Vermont Space Grant Undergraduate Scholarship Competition were announced in May 2014 with undergraduate scholarships awarded for the 2014-2015 academic year. In the general competition, six merit-based scholarships were awarded<sup>1</sup> to outstanding Vermont students who will be attending Vermont institutions of higher learning throughout the state. In coordination with Abenaki Tribal Council of Vermont, the VTSGC identified and solicited applications from outstanding scholars of Abenaki heritage. Two of these six selected scholars were Native Americans and four were women. Thus, 67% of the scholarships were awarded to female students, far exceeding the target of 40% outlined in our FY 2010 proposal. Further, 33% were awarded to members of underrepresented groups. All supported undergraduate students appear to be making excellent progress toward their baccalaureate degrees.

To support this outstanding program, three additional special scholarships of \$2,500 each were awarded during the current reporting period to students in the Aviation Technology Program. As the school calendar for this program differs significantly from the usual academic year, students in this program cannot reasonably compete in the VTSGC's normal Undergraduate Scholarship Competition

In terms of graduate fellowships, the University of Vermont is the only comprehensive institution in the entire State granting graduate degrees in mathematics, science and engineering. This fact explains why the VTSGC Graduate Research Fellowships have been for graduate study at UVM. Fortunately, UVM's graduate programs in mathematics, science and engineering are strong and thriving, especially in the biomedical and remote sensing areas that form the research

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<sup>1</sup> In fact, eight scholarships were offered but two students declined to attend out-of-state institutions.

focus of NASA-related research in Vermont. It is important to note that our graduate awards have a strong research component and are not simply pure fellowships. Recipients work with UVM researchers who have, or are developing links to NASA, and the awards usually contain a summer research stipend as a component.

A total of five Graduate Research Fellowships were awarded that fully supported graduate students for a 12-month period including the 2014-2015 academic year were competitively awarded in the VTSGC's 2014 Graduate Research Competition. This is in alignment with the target of four full-time awards stated in our FY 2010 base budget proposal. Part-time support for one additional Graduate Research Fellowship was embedded in a Small-Scale Grant award. *None* of the awards went to female students this year. This is rather anomalous when compared to our target of 40% of awards for female graduates, and in consideration of our excellent track record in this regard. The part-time support was provided to a student of Asian American descent. Unfortunately, progress toward meeting our target of awarding two Graduate Fellowships to members of an underrepresented group during the 5-year period of our Space Grant award remains a challenge. Potential faculty mentors are always strongly encouraged to propose GRA funding for women, members of underrepresented groups, and persons with disabilities in our yearly Graduate Research Competitions. However, despite this encouragement, UVM, the only graduate program in Vermont, has few graduate students from recognized underrepresented groups in STEM, and none of the graduate students supported in FY 2014 from our base budget funding is a member of an underrepresented group.

Our graduate fellowship program continues to produce excellent outcomes. All graduate students awarded VTSGC Graduate fellowships during the present reporting period are making excellent progress toward earning their degrees. A specific case worth mentioning is David Hinckley, who was also selected by NASA GSFC as an intern with the Navigation and Mission Design Branch developing evolutionary computing approaches to spacecraft trajectory optimizations problems for the period of January – May 2015.

### *1.3 Higher Education Programs:*

**Student Design Teams.** The VTSGC maintains a category of awards called Undergraduate Program Projects to fund many of our efforts in Higher Education. In the current reporting period, two supported design team activities in this category were the NASA Robotic Mining Competition (RMC) and the Alternative Energy Racing Organization (AERO). Both of these design teams were at the University of Vermont. For the RMC team, a dozen students participated in this activity over the past year, and a team of five students attended, for the first time, the NASA-sponsored competition at Kennedy Space Center in May 2015. The AERO student engineering team has over 30 active students and past participation in team activities has provided a pathway to professional employment in Green Energy areas. This past year the AERO team won the General Motors design award for Hybrid Systems Engineering.

**Undergraduate Research.** Other Higher Education activities supported by the VTSGC during the present reporting period enhanced the baccalaureate experience of undergraduate students at Vermont colleges and universities through funding one-on-one faculty Mentored Undergraduate Research Projects while strengthening faculty research efforts and building ties to NASA. A total of 10 undergraduate students participated in these mentored research projects over three Vermont colleges, of which two were female (20%). Of the five faculty mentors

involved in these research projects, one is a member of an underrepresented group; no female faculty were involved this year. At Saint Michael's College (SMC) in Colchester, VT, two mentored undergraduate research projects were active at SMC: "*The synthesis of nanostructured SrO and BaO and their use as catalysts to yield biodiesel from waste phospholipids procured from algae*" and "*Making Use of Quantum Computing: Translating Search Problems to Quadratic Unconstrained Binary Optimization Problems.*" At Norwich University (Northfield, VT) two projects within the Department of Mechanical Engineering: "*Space Case: Bringing Handheld Technology to Space*" and "*Additive Manufacturing in Space.*" Together, these two projects involved six undergraduate male engineering students. Finally, at Vermont Technical College (VTC), the mentored undergraduate research remains centered around the ongoing "CubeSat Lunar Lander Project" that was originally started by a VTSGC/CDC grant in 2009. This mentored undergraduate research project supported two undergraduates, including one female in FY2014.

**Longitudinal Tracking Summary.** Further indicators of Program Accomplishments contributing to Outcome 1 are found in the data provided by the National Space Grant Foundation. Thirty-three students took next step in FY14 (SG participation supported from FY06-FY14 funds): *7 are pursuing advanced degrees in STEM disciplines; 3 accepted STEM positions at NASA contractors; 17 accepted STEM positions in industry; 1 accepted a STEM position in K-12 academia; 2 accepted STEM positions in academia; and 3 went on to positions in non-STEM disciplines.* The remaining students have not yet received the degree that they were pursuing while they received their Space Grant award. Overall, in the period from 2006-2014, 80% of VTSGC students have taken their "next step" in the STEM process, thus demonstrating the achievement of program goals.

## ***Outcome 2: Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers, and faculty (Educate and Engage)***

### 2.1 Higher Education Programs:

Components of several of the VTSGC programs described above give undergraduate students in STEM disciplines a greater appreciation for the breadth and depth of NASA's mission and research opportunities. The mentored undergraduate research projects described in the prior section directly educates and engages students at both the research university level and undergraduate institution level with NASA-related STEM activities in a way that would not be possible without VTSGC sponsorship. In FY 2014, the VTSGC also supported design team educational opportunities that could lead to a career in a STEM discipline. During the current reporting period, the VTSGC focused its support on the fledgling Robotics Mining Competition (RMC) design team at the University of Vermont. Ongoing support was also provided to the Alternative Energy Racing Organization team.

### 2.2 Precollege Programs:

Vermont is a small, predominantly rural state without a well-developed statewide research culture. There are only 53 high schools in the entire state, and, in many school districts, students are not fully aware of opportunities for scientific and technical careers. VTSGC precollege programs are able to access Vermont students at a key location in the pipeline leading to professional careers. Our data shows that the summer enrichment programs we have partially supported, particularly the Summer Mathematics Institute and an underrepresented minority

component for the UVM Summer Enrichment Program in Science and Technology, have been successful in motivating precollege students from across the State. Further, the positive publicity in the press generated by these programs has increased the visibility of NASA throughout the State and facilitated our efforts at both the higher education and research infrastructure levels.

Two annual pre-college design competitions coordinated by UVM's College of Engineering and Mathematical Sciences that involved the VTSGC occurred in FY2014: the *FIRST Tech Challenge* and the *Aiken/ Technology And Society Connection (TASC)*. The VTSGC maintained an exhibit at the FTC this year showcasing our programs and promoting STEM careers. During Aiken/TASC competition, The VTSGC, for the second year in a row, sponsored the merit badge Space Exploration and VTSGC Director Hitt led the activities.

The VTSGC sponsored a high school student from Milton HS to represent State of Vermont at the Congress of Future Science & Technology Leaders in June 2015 in Boston, MA.

The VTSGC continued its support for pre-college programs for STEM middle school instructors in FY14. The VTSGC sponsored the participation of a pair of science teacher from two Vermont middle schools to attend the *2014 FOCUS on: Engineering Workshop* sponsored by the CT Space Grant.

Finally, as a CAPENS Consortium, the VTSGC expends only a modest percentage of our funding on precollege activities. Therefore, our strategy in this area is to partner in K-12 activities whenever possible through state affiliates; specific affiliates include: the Governor's Institute of Vermont, the Vermont State Mathematics Coalition, the Fairbanks Museum & Planetarium, the Montshire Museum of Science, and the Franklin Northwest Supervisory Union Indian Education Office. Through donated efforts of the Director and Program Coordinator, partnered with the listed affiliates, the VTSGC has been able to establish a strong presence in the state and region in the K-12 arena.

***Outcome 3: Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission (Engage and Inspire)***

***3.1 General Public and External Relations Programs:***

The VTSGC takes a multi-faceted and "opportunistic" approach to public and external relations. Firstly, to promote NASA programs in the state and help engage and inspire the STEM students, the VTSGC annually invites special guests address local audiences as part of the VTSGC Awards Ceremony. Secondly, the VTSGC continues to serve as an affiliate of the Vermont Academy of Science and Engineering (VASE), a component of the Vermont Technology Council that advises the State of Vermont on science and technology policy. Thirdly, this year VTSGC operated booths at the 2014 "Manufactured in Vermont" Expo and the Vermont Chamber of Business & Industry Expo; the purpose was to increase the VTSGC's visibility and awareness of its programs within the State's industrial community. Finally, local relations with the offices of Vermont's congressional senators (Patrick Leahy, Bernie Sanders) were strengthened by the VTSGC's hosting of site visits by the senators' staff representatives. During their respective 1-2 hour visits, the staffers were given detailed information on the activities of the VTSGC and laboratory tours at UVM that included the NASA RMC team.

## PROGRAM CONTRIBUTIONS TO NASA EDUCATION PERFORMANCE MEASURES

**Student Data & Longitudinal Tracking** The data presented below for Total Awards to students during the FY 2014 program year indicates that these awards were made through our Fellowship and Scholarship Programs. FY 2014 tracking data provided by the National Space Grant Foundation is as follows:

*Total awards = 22; Fellowship/Scholarship (F/S) = 17, Higher Education/Research Infrastructure<sup>2</sup> = 5; 2 of the total award represent underrepresented minority F/S funding. During the FY14 program year 7 students are pursuing advanced degrees in STEM disciplines, 3 accepted STEM positions as aerospace contractors, 17 accepted STEM positions in non-aerospace areas, 1 accepted a STEM position in K-12 academia, 2 accepted STEM positions in “other” academic fields, and 2 went on to positions in non-STEM disciplines. The remaining students have not yet received the degree that they were pursuing while they received their Space Grant award.*

**Diversity.** Solicitations and announcement of opportunities always contain a section that strongly encourages the participation of women, members of underrepresented groups, and persons with disabilities; this formal encouragement is supplemented by the personal efforts of the VTSGC Director. Data has been presented in the sections above for each of the individual components of our program that compares outcomes during the current reporting period with the targets for diversity contained in our 2010 proposal. Our personnel data indicates overall success within the VTSGC Program in reaching diversity goals; however, the individual successes across the Program vary with the particular activities: Of the five faculty investigators involved in these locally funded research projects, one was of Hispanic descent (20%) and one was of Asian heritage (20%). No female investigators were funded since there were no applications submitted. This was a very unusual development: in FY12, 60% of awards went to female faculty and in FY13, 33% of the awards went to faculty. Overall, we aspire to meet our overall target of 40% over the lifetime of this funding cycle and during the next year we will make special efforts to solicit applications from female investigators. In the Undergraduate Scholarship Competition, two of these six selected scholars were Native Americans and four were women. Thus, 67% of the scholarships were awarded to female students, far exceeding the target of 40% outlined in our FY 2010 proposal. Further, 33% were awarded to members of underrepresented groups. Within the Mentored Undergraduate Projects and Senior Design Teams supported, four female undergraduates were involved. And finally, within the Graduate Fellowships, a two of the five fellowships awarded went to female students. A total of 10 undergraduate students participated in the mentored research projects over three Vermont colleges; of these, two were female (20%). This continues our trend of successfully recruiting female student in our supported mentored undergraduate research projects, although we aspire to increase this percentage. Of the five faculty mentors involved in these research projects, one is a member of an underrepresented group; no female faculties were involved this year.

**Minority-Serving Institution Collaborations.** Less than 5% of Vermont residents identify themselves as members of an underrepresented minority. Vermont has no minority-serving

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<sup>2</sup> These students were members of the NASA Robotic Mining Competition team that was fully supported by the VTSGC

higher educational institutions, or indeed any higher educational institutions with a significant percentage of minority student enrollments. One VTSGC strategy for promoting diversity in our programs involves a strong working relationship Office of Indian Education for Franklin County Public Schools (OIEFCPS) group, the “education arm” of the Abenaki Tribal Council of Northern Vermont. The OIEFCPS, which is also a VTSGC affiliate, cooperates closely with the VTSGC and each year helps us to attract talented students of Abenaki heritage to apply to our Undergraduate Scholarship application pool.

**NASA Education Priorities.** The VTSGC supported two capstone undergraduate engineering design projects and five mentored-undergraduate research teams provided authentic, hands-on student experiences in science and engineering disciplines based on real-life NASA research and technology needs. Support was provided for an underrepresented minority component for the Governor’s Institute of Vermont’s (GIV) Engineering Program; this program provides summer opportunity for secondary students on a college campus with the objective of increased enrollment in STEM disciplines or interest in STEM careers while simultaneously promoting VTSGC Diversity goals. Similarly, the VTSGC also contributed partial support for the GIV Summer Program in Mathematical Sciences

The VTSGC sponsored the participation of two middle school STEM teachers to attend the 2014 FOCUS On: Engineering STEM educator’s professional development workshop organized by the CT SGC and held at Hartford University.

## **IMPROVEMENTS MADE IN THE PAST YEAR**

Notable improvements include the following items. In an effort to increase a larger pool of applicants for the undergraduate scholarship competition, the annual application deadline was moved earlier to March 1. This action was taken after a Consortium decision that later application date was causing the loss of potential applicants due to admissions decisions already being made by April. The VSTGC added a Facebook page ([www.facebook.com/vtspacegrant](http://www.facebook.com/vtspacegrant)) to its existing portfolio of social media (Twitter and LinkedIn). Mansfield HeliFlight of Milton, VT was added as a new strategic partner from Vermont industry. The VTSGC supported the first competing team in the NASA Robotic Mining Competition.

## **PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION.**

The University of Vermont is the VTSGC’s Lead Institution and Fiscal Agent. The primary academic affiliates include: St. Michael’s College, a Liberal Arts college in Colchester, VT; Norwich University, a comprehensive school with engineering programs in Norwich, VT; Vermont Technical College (VTC), part of the Vermont State College System in Randolph, VT; and the Aviation Technology School of the Burlington Technical Center (BTC). Other educational organizations that are VTSGC affiliates are the Vermont State Mathematics Coalition (VSMC), the Fairbanks Museum and Planetarium, the Montshire Museum, and the Office of Indian Education for Franklin County Public Schools (OIEFCPS). The linkage of the VSMC with the statewide Space Grant network allows the VTSGC to be a stakeholder in K-12 education with only a small outlay of our own funding. The Fairbanks Museum and Planetarium and the Montshire Museum are both informal education providers with highly successful, nationally acknowledged programs serving the general public. The OIEFCPS promotes the educational objectives of the Abenaki Tribal Council of Northern Vermont. Continuing industrial affiliates the VTSGC include: Triangle Metal Fabrications of Milton, VT; LORD/Microstrain, Inc. of Williston, VT; and Archimedes Aerospace LLC of Burlington, VT.

During the past year, the VTSGC added Mansfield HeliFlight of Milton, VT as a new industrial strategic partner. All of these companies have provided significant support and/or training for VTSGC-supported students and engineering groups/teams.